DEVELOPMENT OF A MICROBIOLOGICAL PROFILE AND ANTIBIOGRAM TARGETING RESISTANT BACTERIAL SUPERBUGS IN SURGERIES

A Synopsis of the thesis
submitted for the award of
degree of

DOCTOR OF PHILOSOPHY

In

PHARMACEUTICAL SCIENCES

(FACULTY OF PHARMACY)

Submitted to

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May, 2025

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1. ABSTRACT

Background:
The emergence of multidrug-resistant (MDR) bacterial pathogens, commonly referred to as "superbugs," poses a significant threat in surgical settings, leading to complications, prolonged hospital stays, and increased mortality. Understanding the microbiological profile and resistance patterns is critical for effective management and targeted antimicrobial therapy.

Objectives:
To develop a comprehensive microbiological profile and antibiogram for surgical patients, focusing on the identification of resistant bacterial superbugs and determining their susceptibility to various antimicrobial agents.

Methods:
A prospective observational study was conducted in a tertiary care hospital. Clinical samples (e.g., wound swabs, blood, urine) were collected from surgical patients with suspected infections. Microorganisms were identified using standard microbiological techniques. Antibiotic susceptibility was assessed using the Kirby-Bauer disk diffusion method and automated systems. Data were analysed to construct an antibiogram and identify resistance patterns.

Results:
The study demonstrates a clear association between specific comorbidities and the risk of SSIs. The distribution of patients and SSIs across departments in this study reflects the varying risk profiles of different types of surgeries. General surgery and gynaecology procedures contribute a significant number of SSIs, likely due to the invasive nature of many of the surgeries in these departments. Orthopaedic procedures, particularly joint replacements, are also associated with a higher risk of SSIs due to the use of implants. The prevalence of MRSA (23.7%) and MSSA (76.3%) observed in this study aligns with global trends but underscores the ongoing challenge of managing antibiotic-resistant infections in clinical settings. The predominant pathogens isolated included Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Staphylococcus aureus. A significant proportion of isolates exhibited resistance to commonly used antibiotics, including third-generation cephalosporins, fluoroquinolones, and aminoglycosides.

Conclusions:
The development of a targeted microbiological profile and antibiogram is essential for guiding empiric and definitive antimicrobial therapy in surgical settings. Continuous surveillance, strict infection control measures, and antimicrobial stewardship programs are imperative to combat the growing threat of resistant bacterial superbugs.

Keywords:
Antibiogram, superbugs, surgical infections, multidrug resistance, antimicrobial stewardship.

2. INTRODUCTION

Surgical Site Infections (SSIs) constitute a major subset of healthcare-associated infections worldwide, posing serious implications for patient well-being and placing a significant strain on healthcare systems. Despite advancements in surgical procedures and infection prevention protocols, SSIs continue to contribute substantially to illness, death, and financial costs globally (1). According to the World Health Organization (WHO), between 2% and 5% of patients undergoing inpatient surgery in developed nations experience SSIs, with incidence rates often exceeding 15% in low- and middle-income countries (2). These infections not only prolong hospitalizations but also elevate healthcare expenditures and may result in severe complications if left unmanaged.

The epidemiology of SSIs is multifaceted and involves numerous bacterial pathogens. Among the most common culprits are *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* species, and *Pseudomonas aeruginosa* (4,6). A particularly alarming issue is the rise of multidrug-resistant (MDR) organisms commonly referred to as "superbugs" which complicate treatment efforts (10). Notably, methicillin-resistant *Staphylococcus aureus* (MRSA) and extended-spectrum beta-lactamase (ESBL) producing Gram-negative bacteria have been linked to adverse clinical outcomes and elevated mortality rates (10, 8). Factors such as improper antibiotic usage, insufficient infection control, and restricted access to effective antimicrobials especially in resource limited areas are key contributors to the spread of these resistant strains (5,9,15).

Antimicrobial resistance (AMR) has been labelled a critical public health threat by both the WHO and the Centers for Disease Control and Prevention (CDC). The CDC's 2019 assessment designates carbapenem-resistant *Enterobacteriaceae* and MRSA as high-priority threats, highlighting the necessity for robust monitoring and targeted interventions (2,8).

Local antibiograms comprehensive reports summarizing antimicrobial susceptibility data have proven essential for guiding clinicians in selecting appropriate treatments and reducing inappropriate antibiotic use (3,6). It is found that facility-specific antibiograms greatly enhance antimicrobial stewardship by informing empirical therapy decisions based on local resistance data (6). The Clinical and Laboratory Standards Institute (CLSI)

supports these efforts by providing regularly updated protocols for susceptibility testing to ensure accuracy and consistency in antibiogram development (3).

In resource-limited settings, the dual burden of SSIs and antibiotic resistance is aggravated by inadequate infection prevention infrastructure and limited diagnostic capabilities (5,19). Research conducted in countries such as India and Ethiopia reveal worryingly high rates of MDR organisms in surgical wounds, often associated with prolonged hospital stays and negative patient outcomes (9,20). A multi-center investigation by Kothari and Sagar in India highlights the pressing need for localized resistance data to inform treatment guidelines and enhance antibiotic usage (17).

Global health strategies increasingly emphasize the implementation of antimicrobial stewardship programs (ASPs) to combat the misuse of antibiotics and curb the rise of resistance (14). Beyond stewardship, effective microbiological surveillance is vital for detecting resistance trends and identifying outbreaks early (5,7). Some studies argue that while the discovery of new antibiotics remains sluggish, optimizing the use of existing drugs through surveillance and stewardship is crucial to managing resistant infections (7). Bassetti et al. emphasize the limited pipeline for new treatments against MDR Gram-negative bacteria, underscoring the importance of alternative strategies such as rapid diagnostics and enhanced infection control (16).

Given the diversity of pathogens and resistance patterns associated with SSIs, personalized approaches to antibiotic treatment and infection control are essential at the institutional level (18). Researches reveal significant variability in resistance profiles across regions, surgical specialties, and patient demographics, necessitating regular updates to local antibiograms for continued clinical relevance (10).

In summary, the persistent problem of SSIs, worsened by the rise of drug-resistant pathogens, calls for a multifaceted response involving surveillance, stewardship, and stringent infection control. Developing institution-specific microbiological profiles and antibiograms is essential for guiding empirical antibiotic therapy, minimizing the development of resistance, and improving clinical outcomes. This study seeks to address these challenges by identifying the bacterial pathogens associated with surgical wounds, evaluating their antimicrobial resistance patterns, and contributing to more informed antibiotic use in surgical settings.

3. AIM AND OBJECTIVES

AIM:

To develop a microbiological profile and antibiogram of resistant bacterial pathogens causing SSIs in a tertiary care hospital.

OBJECTIVES:

- To associate the clinical demographic characteristics of patients with and without bacterial isolates.
- To study the various types (proportion) of bacterial isolates causing SSI's and their susceptibility pattern.
- To develop microbiological profile by evaluating the antibiotic sensitivity and resistance to the pathogens
- To develop a comprehensive anti-biogram based on the susceptibility test to support empirical antibiotic selection for SSIs.
- To compare the SSI events on basis of drug intervention.

4. HYPOTHESIS/RESEARCH QUESTIONS

To explore the relationship between various factors (such as surgical type, patient demographics, and antibiotic resistance) and to develop an understanding of the microbial and resistance profiles in surgical site infections (SSIs).

Research Question:

- What are the bacterial species responsible for surgical site infections (SSIs) in patients undergoing surgeries at a tertiary care hospital?
- What is the antibiotic resistance profile of the bacterial isolates from SSIs, and how does it vary across different surgical departments?
- Are certain patient demographic factors (age, gender, comorbidities) associated with an increased likelihood of developing antibiotic-resistant infections after surgery?

- Can an antibiogram be developed to guide appropriate antibiotic therapy for SSIs in the hospital setting?

5. REVIEW OF LITERATURE

- **In 2024** Vishal L.Handa et al; conducted a study on **"A study of antibiotic resistance pattern of clinical bacterial pathogens isolated from patients in a tertiary care hospital"** concluded that Cephalosporin and fluoroquinolone antibiotics show poor activity in controlling bacterial pathogens. Tetracyclines and aminoglycosides effectively control *Escherichia-coli*, *Enterobacter* spp., *Klebsiella-pneumoniae*, *Acinetobacter* spp.
- **In 2023** Nikol kaderabkova et al; conducted a study on **"Antibiotic susceptibility testing using minimum inhibitory concentration (MIC) assays"** concluded that although MIC assays are commonly associated with antibiotic compounds, similar experiments can be used to study the effects of many other chemical agents on bacterial growth.
- **In 2022** M.A.Lavanya et al; conducted a study on **"The Economic Burden of Antibiotic Resistance Based on Anti-microbial Susceptibility Tests in Various Infections in a Tertiary Care Hospital: A Prospective Study"** concluded that that the resistant patients without antibiotic sensitivity testing had a significantly higher financial burden. Therefore, they strongly recommend to perform antibiotic sensitivity testing (AST) in patients with infectious diseases.
- **In 2021** Gemedo misha et al; conducted a study on **"Bacterial profile and antimicrobial susceptibility patterns of isolates among patients diagnosed with surgical site infection at a tertiary teaching hospital in Ethiopia: a prospective cohort study"** concluded that Gram- negative bacteria were the most dominant isolates from surgical sites in the study area.
- **In 2021** Brenna M.Roth,S et.al., conducted a study on **"Antibiogram development in the setting of a high frequency of multi-drug-resistant organism at University teaching hospital, Lusaka, Zambia**". Antibiograms provide guidance on the effective management of infections and appropriate use of antibiotic therapy based on local AMR patterns.

- **In 2020,** Aynishet Adane, Gizeaddisa Baley & Koku Sisay Tamirat conducted a study on **"Microbiological profile of drug resistance pattern of pathogens among patients who visited the University of Gondar comprehensive specialized hospital, Ethiopia".** The studies stated that most of the bacteria has less resistance to most routinely used antibiotics like carbapenems and 4th generation cephalosporins. They conclude that three antibiotics help in preventing the bacterial infections.
- **In 2019** Manoj V Jani, N. K. Gupta et al; conducted a study on **"Antimicrobial Resistance Pattern of Bacterial Isolates from Endotracheal Aspirate of Ventilated Patients at a Tertiary care hospital"** concluded that the isolation and antimicrobial resistance pattern of the microorganisms is necessary for their effective management.
- **In 2017** Zaman, et al has been conducted a study on **"Antibiotic Resistance" to elaborate the importance on resistance of infections ie, pneumonia, TB, gonorrhea are less effective to antibiotics.** This study clearly shows that AB resistance is at all-time high in all parts of the world, the high economic burden in health care sector is major issue. Both global policies need to be conventional and adhered to stop "over use and misuse of antibiotics".
- **In 2016** Slipi Basak, Priyanka singh et al; conducted a study on **"Multidrug resistant and Extensively Drug-resistant bacteria: A study"** concluded that early detection and close monitoring of MDR, XDR or even PDR bacterial strains must be started by all clinical microbiology laboratories to reduce the menace of antimicrobial resistance which is now a global problem.

6. METHODOLOGY

PLACE OF STUDY: The study **"DEVELOPMENT OF A MICROBIOLOGICAL PROFILE AND ANTIBIOGRAM TARGETING RESISTANT BACTERIAL SUPERBUGS IN SURGERIES"**, which was carried out in the 'Department of Surgery' IP at Government General Hospital, Nellore, a 750 bedded multi – disciplinary tertiary care teaching hospital.

PERIOD OF STUDY: 3.5 years

STUDY DESIGN: A prospective cross-sectional study and cohort study

SAMPLE SIZE:

A sample size (n') for a population proportion (>10000) at confidence level p and q, q=1-p with a specific margin of error, E and number of standard deviations of the sample from its mean, z-score can be determined using the following equation

$$n' = p.q(z/E)^2$$

Usually, p value is the determined as

- 0.1 at confidence level of 99%
- 0.5 at confidence level of 95%

q (1-p) values at 3 confidence levels are 0.9 and 0.5

Z- Score value for 95% CI -1.96

E is the desired margin of error and is accepted 5% which gives a value of 0.04-0.07.

- The sample size at 4% margin error with 95% confidence level is **601 patients.**
- Actual sample size **N=738**

STUDY POPULATION: 738 Cases

PATIENT ENROLLMENT:

Patients are enrolled in the study based on inclusion and exclusion criteria

a. Inclusion criteria:

- Willing to participate in the study
- Admitted in various departments with surgical site infections
- Above 10yrs of age

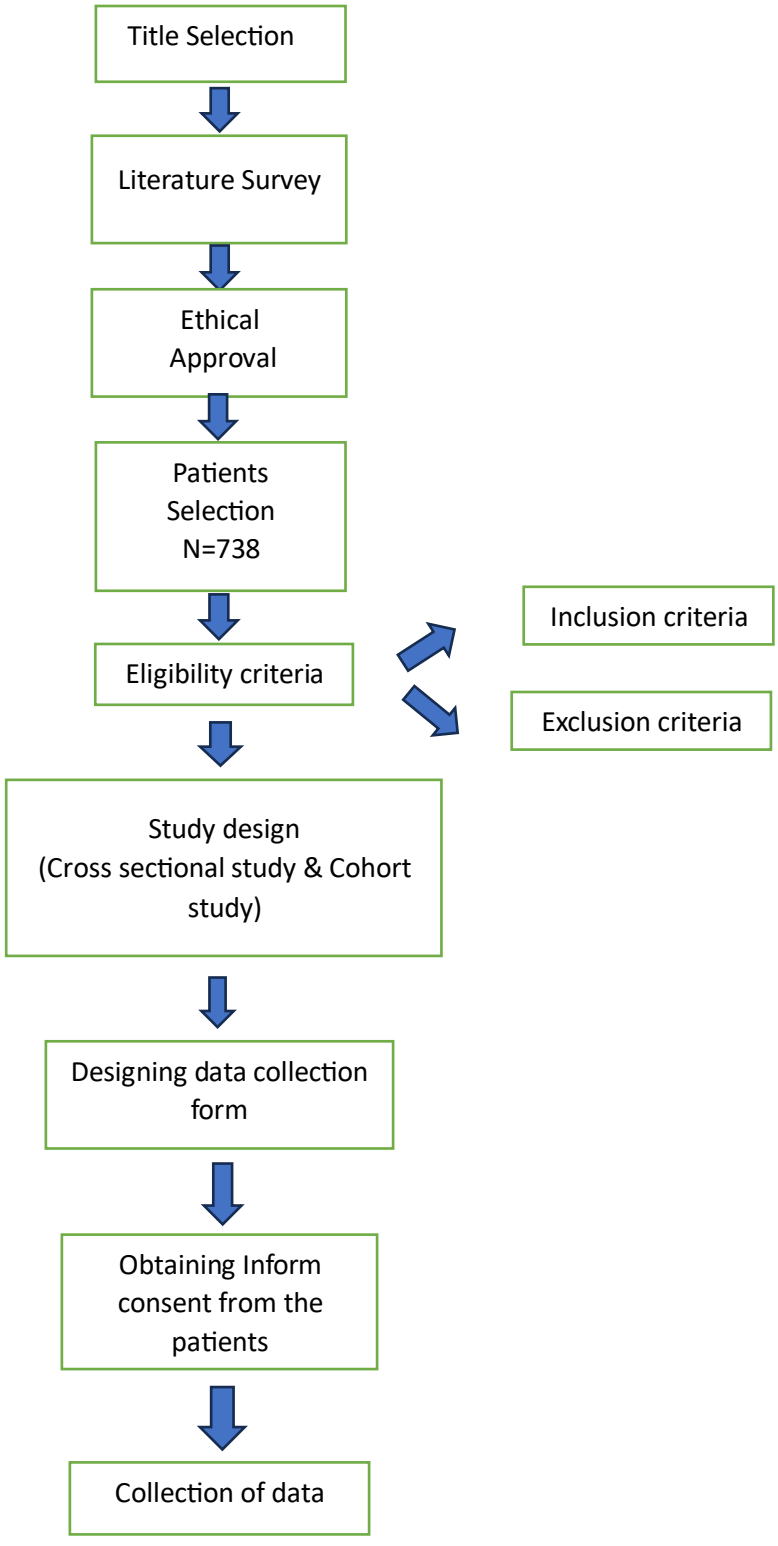
b. Exclusion criteria:

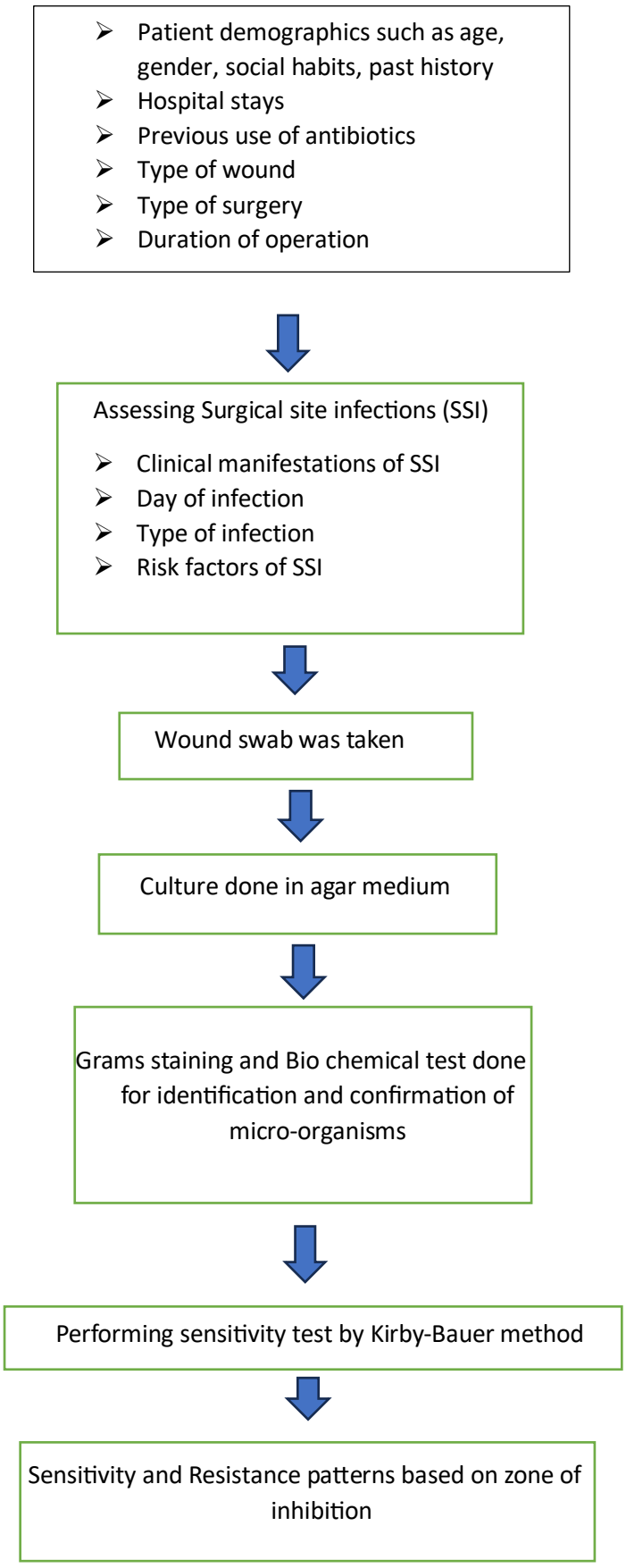
- Infected with burns and surgical patients with community acquired infections such as furuncle and patients with infections of an episiotomy
- Below 10yrs of age
- Not willing to participate in the study

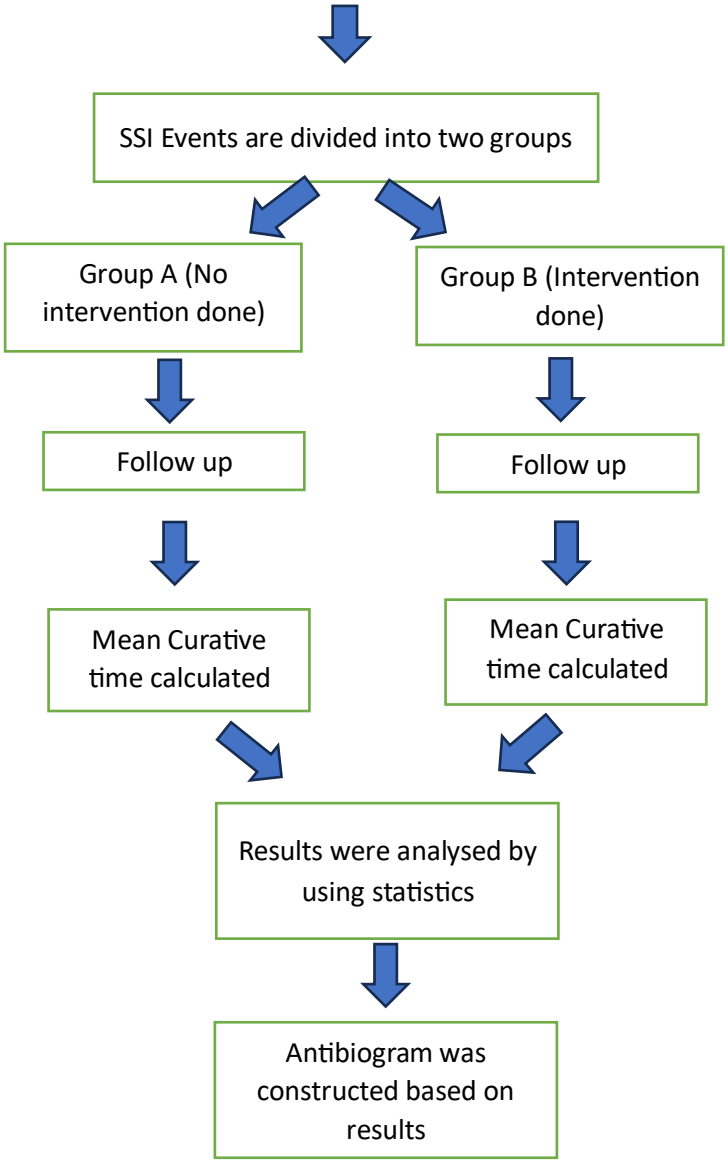
STUDY MATERIALS:

- Patient Data Collection Form (Annexure - I)
- Patient Inform Consent Form (Annexure - II)
- Antibiotic sensitivity report form (Annexure - III)

METHOD OF STUDY:




Patient demographics such as age, gender, social habits, past history
Hospital stays
Previous use of antibiotics
Type of wound
Type of surgery
Duration of operation
Assessing Surgical site infections (SSI)
Clinical manifestations of SSI
Day of infection
Type of infection
Risk factors of SSI
Wound swab was taken
Culture done in agar medium
Grams staining and Bio chemical test done for identification and confirmation of micro-organisms
Performing sensitivity test by Kirby-Bauer method
Sensitivity and Resistance patterns based on zone of inhibition


SSI Events are divided into two groups
Group A (No intervention done)
Group B (Intervention done)
Follow up
Follow up
Mean Curative time calculated
Mean Curative time calculated
Results were analysed by using statistics
Antibiogram was constructed based on results

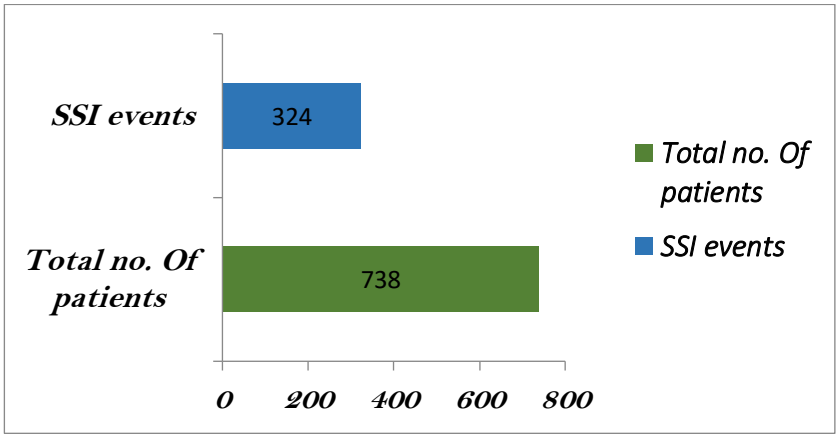
STATISTICAL ANALYSIS:

- Descriptive Statistics: Frequency Distributions, Percentage Distribution
- Inferential Statistics: Chi-Square Test for Association, Mann-Whitney U test

7. RESULTS AND DISCUSSION

Patients with Surgical Site Infections

A total number of 738 patients' details were collected and out of those 324 patients were found to be affected with Surgical Site Infections.



Incidence

The overall incidence of the surgical site infections in the present study was **43.9%**

Table 1: Association of clinical demographics with and without bacterial isolates

Variable	Total no. of patients screened n=738	No SSI events (%) n =414	SSI events (%) n =324
I.Patient age (years)			
Below 20	125	66 (52.8%)	59 (47.2%)
20-30	139	78 (56.1%)	61 (43.9%)
30-40	242	141 (58.3%)	101 (41.7%)
40-50	119	64 (53.8%)	55 (46.2%)
Above 50	113	65 (57.5%)	48 (42.5%)
II.Patient gender			
Female	413	241 (58.4%)	172 (41.6%)
Male	325	173 (53.2%)	152 (46.8%)

III.Hospital stays			
Below 10 days	234	110 (47%)	124 (53%)
Above 10 days	504	304 (60.3%)	200 (39.7%)
IV.Department			
General surgery	323	221 (68.4%)	102 (31.6%)
Gynecology	181	75 (41.4%)	106 (58.6%)
Orthopedics	104	56 (53.8%)	48 (46.2%)
Ophthalmology	69	39 (56.5%)	30 (43.5%)
ENT	61	23 (37.7%)	38 (62.3%)
V.Type of surgery			
Elective	658	392 (59.6%)	266 (40.4%)
Emergency	80	22 (27.5%)	58 (72.5%)
VI.Type of wound			
Clean wound	252	127 (50.4%)	125 (49.6%)
Clean contaminated wound	365	193 (52.9%)	172 (47.1%)
Contaminated wound	119	92 (77.3%)	27 (22.7%)
Dirty wound	2	2 (100%)	0 (0%)
VII.Duration of surgery			
≤45 mins	326	219 (67.2%)	107 (32.8%)
45 mins to 1 hour	224	68 (30.4%)	156 (69.6%)
≥1 hour	188	127 (67.6%)	61 (32.4%)
VIII.Preoperative antibiotic prophylaxis			
Given	566	333 (58.8%)	233 (41.2%)
Not given	172	81 (47.1%)	91 (52.9%)
IX.Postoperative antibiotic treatment			
Given	596	371 (62.2%)	225 (37.8%)
Not given	142	43 (30.3%)	99 (69.7%)

- Age distribution shows the highest number of patients (242) were in the 30-40 years group. SSI events were relatively lower in the 30-40 group (41.7%), and higher in the Below 20 group (47.2%). According to Levi et al. (2018), middle-aged adults are more likely to develop infections due to the cumulative effects of age and lifestyle factors like hypertension or diabetes (Levi et al., 2018). According to statistical analysis there was no clinical association as P value is **0.85** (Based on Chi-square test)

- Out of 738 patients, females (413) outnumbered males (325). Females had a higher rate of No SSI events (58.4%) compared to males (53.2%). Consequently, males experienced a higher proportion of SSI events (46.8%) than females (41.6%), indicating gender may influence SSI susceptibility. A study by Berg et al. (2016) found that men had a significantly higher risk of developing SSIs in orthopedic surgeries, likely due to higher rates of smoking, alcohol use, and obesity among male patients. According to statistical analysis there was no clinical association as P value is **0.19** (Based on Chi-square test)

- Patients staying more than 10 days (504) were more prevalent than those staying below 10 days (234). However, SSI events were significantly higher in patients with shorter stays (53%), compared to those staying above 10 days (39.7%). Patients discharged within 10 days are 1.71 times more likely to develop SSIs. A study by Fitzgerald et al. (2019) employed logistic regression to analyze hospital stay length and infection risk. Their findings indicated that longer stays were indeed a significant predictor of SSIs, independent of other risk factors like age and comorbidities. According to statistical analysis there was strong clinical association as P value is **0.00093** (Based on Chi-square test)

- General Surgery had the most patients (323), followed by Gynecology (181) and Orthopedics (104). ENT had the highest SSI event rate (62.3%), despite a smaller sample size, followed by Gynecology (58.6%). Patel et al. (2018) observed that caesarean sections and hysterectomies are among the procedures with the highest rates of SSIs in gynaecology, especially when performed on high-risk patients. Department shows strong statistically significantly association with SSI events as P value is **0.00000052** (Based on Chi-square test)

- Elective surgeries accounted for the majority of procedures (658 cases) with an SSI incidence: 40.4%. Emergency surgeries had a much higher SSI rate comprising SSI incidence of 72.5%. Emergency patients are nearly 1.8x more likely to develop an SSI. Williams et al. (2016) found that the infection rate in emergency surgeries can range from 20-30%, particularly in surgeries involving gastrointestinal perforations or trauma. Shows Statistically significant association as P value is **0.00000093** (Based on Chi-square test)

- Type of wound also shows Statistically significant association as P value is **0.000033** (Based on Chi-square test)

- Highest SSI rate found in medium-duration surgeries (69.6%). Shorter and longer surgeries have much lower infection risks. Edmiston et al. (2017) noted that surgeries lasting between 45 minutes and 1 hour are often associated with an increased risk of infection due to the extended exposure to microorganisms in the operating environment. Duration of surgery shows extremely statistically significantly association with SSI events as P value is **0.00000000016** (Based on Chi-square test)

- Postoperative antibiotics seem more effective than preoperative ones in reducing infection rates. Patients without pre-op antibiotics are 28% more likely to develop an SSI. It is likely statistically significant. Huge difference in SSI rates, nearly 32% drop when antibiotics are given. Patients without post-op antibiotics are 1.8x more likely to develop SSIs and very likely to be highly significant.

- Further, a study by Classen et al. (1992) demonstrated that the timing of antibiotic administration is crucial; antibiotics given within an hour before the incision have the highest efficacy in preventing SSIs. Both preoperative and post operative are statistically significant as P values are **0.0086** and **0.000000010** respectively.

Categorization based on past medical history

- Diabetes Mellitus are the conditions most frequently associated with SSIs, with over 60% of patients in those categories developing SSI. Hypertension also showed a moderately high SSI rate at 52.6%. Prolonged steroid usage, despite clinical expectations, showed a relatively lower SSI rate (43.6%) and no statistical significance. In this study, the past medical history of 738 patients screened for Surgical Site Infections (SSIs), with a total of 324 SSI events.

➢ Hojat et al. (2018) found that patients with uncontrolled hypertension had an increased risk of SSIs, likely due to the effects of high blood pressure on microcirculation, leading to poor tissue oxygenation and healing. Strong associations were found between diabetes, hypertension, "other" conditions, and the absence of comorbidities with SSI events.

➢ Prolonged steroid usage showed no significant association with SSI events (p = 1.0).

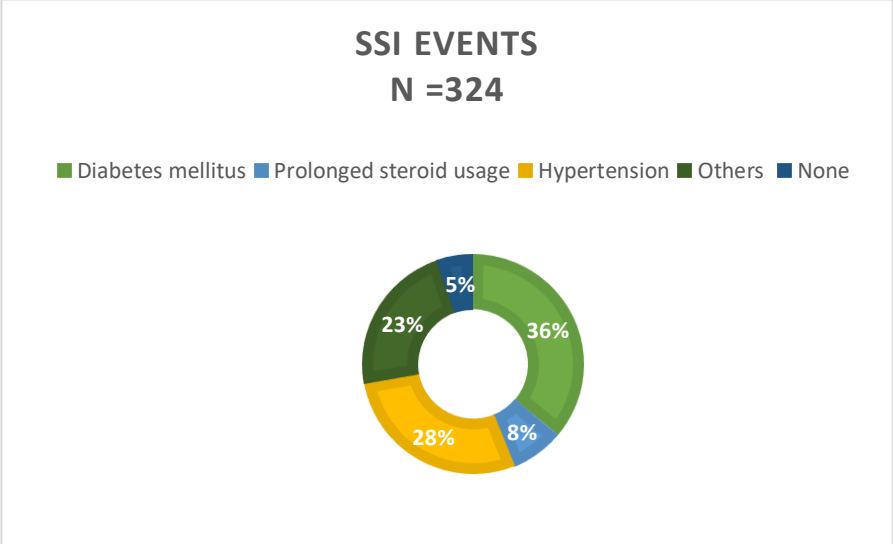


Fig no:1

Categorization based on type of SSI

Table – 2: Distribution of patients based on type of SSI

Type of SSI's	SSI events (%) n=324
Superficial incisional	141 (43.5%)
Deep incisional	176 (54.3%)
Organ / body space	7 (2.2%)

➢ In this study, 176 cases of deep incisional SSIs were recorded, representing 54.3% of total SSIs.

➢ Deep incisional infections are considered more severe than superficial infections and are often associated with higher morbidity. Liu et al. (2017) found that deep incisional SSIs were responsible for 60-70% of all SSIs in abdominal surgeries and orthopaedic procedures, reflecting the complexity and higher contamination risk involved in these surgeries.

➢ Deep incisional infections dominate, indicating potentially more serious wound complications that might require aggressive intervention. The standard deviation is high (≈72.84), indicating substantial variability in the number of events per category. Organ/body space infections are rare, but clinically they are often more serious despite their lower frequency.

Incidence of surgical site infections in relation to different types of surgical procedures

➢ The occurrence of surgical site infections (SSIs) is a significant concern for patient outcomes after surgery. SSIs increase morbidity, hospital stays, and healthcare costs. This study evaluates the incidence of SSIs across different types of surgeries in a cohort of 324 patients.

➢ The frequencies and percentages of SSIs for various procedures were discussed and compare the results with relevant literature to understand trends and risks associated with these infections. The overall incidence of SSIs in this cohort was variable across different surgical procedures.

➢ The most common SSIs were observed in appendicectomy, tubectomy, tendon repair, and SICS + PCIOL, while mastectomy had the lowest incidence of infection.

Table – 3: Incidence of surgical site infections in relation to different types of surgical procedures

Type of surgical procedures	Total No. of patients N=738	Frequency and percentage of surgical site infections (%)
Appendicectomy	131 (17.8%)	46 (14.2%)
Hydrocelectomy	36 (4.9%)	10 (3.1%)

Hysterectomy	22 (3%)	18 (5.6%)
Surgical debridement	45 (6.1%)	23 (7.1%)
Herniotomy	59 (8%)	15 (4.6%)
Tubectomy	101 (13.7%)	71 (21.9%)
Mastectomy	20 (2.7%)	2 (0.6%)
Tendon repair	58 (7.9%)	30 (9.3%)
Knee replacement	46 (6.2%)	18 (5.6%)
SICS + PCIOL	69 (9.3%)	30 (9.3%)
Caesarian	58 (7.9%)	17 (5.2%)
Tonsillectomy	38 (5.1%)	22 (6.8%)
Tympanoplasty	23 (3.1%)	16 (4.9%)
Others	32 (4.3%)	6 (1.9%)

Organisms isolated from various clinical samples

Out of 324 SSI's, 328 organisms were isolated from various clinical samples such as from blood-130, pus-50, fluid-30, urine-81, ear swab-17 and corneal scraping-30.

Table 4: Distribution of Organisms isolated from various clinical samples

Specimen type	Staphylococcus (MSSA)	MRSA	Streptococcus	E. coli	Klebsiella	Pseudomonas	Gonococci	Pneumococci	Proteus	Total
Blood	32	10	14	36	12	12	4	4	6	130 (38.46%)
Pus	9	3	12	10	6	4	2	4	-	50 (14.8%)
Fluid	9	-	2	2	4	8	-	2	3	30 (8.88%)
Urine	16	8	13	24	11	3	2	-	4	81 (23.97%)
Ear swab	-	2	-	-	-	11	-	-	4	17 (5.03%)

Corneal scrapping	8	-	5	-	-	12	2	3	-	30 (8.88%)
Total	74	23	46	72	33	50	10	13	17	338

- The most common pathogen isolated from blood samples was Staphylococcus (MSSA), accounting for 32 isolates, followed by E. coli (36 isolates). Blood specimens accounted for 38.5% of the total samples, which is consistent with the clinical relevance of bloodstream infections. Blood specimens had the highest microbial load overall, especially E. coli (36) and MSSA (32).

- Urine samples represented 24% of the isolates, highlighting the importance of urinary tract infections (UTIs) in this patient population. Pus samples (14.79%) and fluid samples (8.88%) are also clinically significant, reflecting common sources of infection, particularly in surgical or traumatic wounds. Pseudomonas was especially prevalent in corneal scrapings (12) and ear swabs (11) much higher than expected. E. coli and Staphylococcus (MSSA) were dominant in urine and blood. Fluid specimens showed more Pseudomonas than expected.

- The p-value is much less than 0.05, indicating a statistically significant association between the type of specimen and the type of microorganism isolated.

BACTERIAL DISTRIBUTION OF MICROORGANISMS FROM VARIOUS DEPARTMENTS

A total of 338 microorganisms were isolated from 324 SSI samples and were categorized based on various departments as represented in table – 5.

- The total number of isolates was 338, with a varied distribution across departments. The most commonly isolated microorganisms were Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Klebsiella pneumoniae, which were identified in differing frequencies depending on the department.

- The surgical department had the highest number of isolates (107), followed by gynecology (109). Staphylococcus aureus (38 isolates) and E. coli (16 isolates) were

notably high in the surgical department, while Klebsiella (23 isolates) was most commonly isolated from gynaecology.

➢ The p-value is extremely small i.e. is **$2.42*10^{-35}$** which indicates that there is a statistically significant association between the type of microorganism and the department from which the specimen was collected. Gynecology has a strong association with E. coli. ENT is notably associated with Proteus and Pseudomonas. Streptococcus is particularly prominent in the Surgical department.

Table 5: Bacterial distribution of microorganisms from various departments

Microorganism Isolated	Departments				
	Surgical	Gynecology	Orthopedics	Ophthalmology	ENT
Pseudomonas	7	0	14	12	17
Klebsiella	6	23	4	0	0
E. Coli	16	54	2	0	0
Proteus	3	1	3	0	10
Pneumococci	2	6	2	3	0
Gonococci	8	0	0	2	0
Staphylococcus	38	22	15	8	14
Streptococcus	27	3	11	5	0
Total(n=338)	107	109	51	30	41

MICROBIOLOGICAL PROFILE BASED ON SUSCEPTIBILITY PATTERN

Anti-microbial susceptibility pattern is shown as below:

A total of 338 organisms were isolated from 324 SSI patients and among them;

74 organisms were identified as Methicillin Sensitive Staphylococcus species in which 8 organisms shown sensitive to ceftriaxone, 67 sensitive to gentamicin, 25 sensitive to ciprofloxacin, 57 sensitive to ceftazidime, 28 sensitive to penicillin, 15 to metronidazole, 54 to piptaz, 24 to cefixime and 41 to cefotaxime.

23 organisms were identified as Methicillin Resistant Staphylococcus species in which 14 organisms shown sensitive to ceftriaxone, 11 sensitive to amikacin, 16 sensitive to gentamicin, 3 sensitive to ampicillin, 18 sensitive to ceftazidime, 1 sensitive to penicillin, 11 to augmentin, 18 to cefixime and 7 to cefotaxime.

46 organisms were identified as Streptococcus species in which 22 organisms shown sensitive to ceftriaxone, 15 sensitive to amikacin, 42 sensitive to gentamicin, 17 sensitive to ciprofloxacin, 31 sensitive to ceftazidime, 34 sensitive to penicillin. 16 to piptaz, 23 to augmentin and 14 to cefixime.

72 organisms were identified as E.coli in which 14 organisms shown sensitive to ceftriaxone, 26 sensitive to amikacin, 64 sensitive to gentamicin, 6 shown sensitive to ampicillin, 17 shown sensitive to ciprofloxacin, 48 sensitive to ceftazidime, 17 sensitive to penicillin, 44 to piptaz, 44 to norfloxacin and 45 to cefotaxime.

33 organisms were identified as Klebsiella species in which 19 organisms shown sensitive to ceftriaxone, 22 sensitive to amikacin, 22 sensitive to gentamicin, 20 sensitive to ampicillin, 23 sensitive to ciprofloxacin, 25 sensitive to ceftazidime, 20 to Augmentin and 21 to cefotaxime.

50 organisms were identified as Pseudomonas species in which 24 organisms shown sensitive to ceftriaxone, 23 sensitive to amikacin, 37 sensitive to gentamicin, 23 sensitive to ciprofloxacin, 28 sensitive to ceftazidime, 18 sensitive to penicillin, 30 to Augmentin, 31 to cefixime and 18 to cefotaxime.

13 organisms were identified as Pneumococci in which 5 organisms shown sensitive to ceftriaxone, 4 sensitive to amikacin, 9 sensitive to ampicillin, 13 sensitive to ciprofloxacin, 5 sensitive to penicillin and 9 to norfloxacin.

10 organism was identified as Gonococci in which 7 organisms shown sensitive to ceftriaxone, 4 sensitive to amikacin, 4 sensitive to ampicillin, 7 sensitive to ciprofloxacin, 6 sensitive to piptaz and 8 to norfloxacin.

17 organisms were identified as Proteus species, 9 organisms shown sensitive to ceftriaxone, 0 sensitive to amikacin, 17 sensitive to gentamicin, 7 sensitive to ampicillin, 4 sensitive to piptaz and 5 to norfloxacin.

Table- 6: Antimicrobial susceptibility pattern of bacterial pathogens isolated from SSI

Organism	*Antimicrobial Agents*													
	Pattern	***Ceftriaxone***	***Amikacin***	***Gentamicin***	***Ampicillin***	***Ciprofloxacin***	***Ceftazidime***	***Penicillin***	***Metronidazole***	***Piptaz***	***Augmentin***	***Cefixime***	***Norfloxacin***	***Cefotaxim***
Staphylococcus (MSSA) n= 74	***R***	***66***	***NT***	***07***	***NT***	***49***	***17***	***46***	***59***	***20***	***NT***	***50***	***NT***	***33***
	S	***8***		***67***		***25***	***57***	***28***	***15***	***54***		***24***		***41***
Staphylococcus (MRSA) n= 23	***R***	***9***	***12***	***7***	***20***	***NT***	***5***	***22***	***NT***	***NT***	***12***	***5***	***NT***	***16***
	S	***14***	***11***	***16***	***3***		***18***	***1***			***11***	***18***		***7***
Streptococcus n= 46	***R***	***24***	***31***	***04***	***NT***	***29***	***15***	***12***	***NT***	***33***	***23***	***32***	***NT***	***NT***
	S	***22***	***15***	***42***		***17***	***31***	***34***		***16***	***23***	***14***		
E. coli n= 72	***R***	***58***	***46***	***08***	***66***	***55***	***24***	***55***	***NT***	***28***	***NT***	***NT***	***26***	***27***
	S	***14***	***26***	***64***	***06***	***17***	***48***	***17***		***44***			***44***	***45***
Klebsiella n= 33	***R***	***14***	***11***	***11***	***13***	***10***	***08***	***NT***	***NT***	***NT***	***13***	***NT***	***12***	***NT***
	S	***19***	***22***	***22***	***20***	***23***	***25***				***20***		***21***	

Pseudomonas	***R***	***26***	***27***	***13***	***NT***	***27***	***22***	***32***	***NT***	***NT***	***20***	***19***	***NT***	***32***
n= 50	***S***	***24***	***23***	***37***		***23***	***28***	***18***			***30***	***31***		***18***
Pneumococci	***R***	***08***	***09***	***NT***	***04***	***00***	***NT***	***08***	***NT***	***NT***	***NT***	***NT***	***4***	***NT***
n= 13	***S***	***05***	***04***		***09***	***13***		***05***					***9***	
Gonococci	***R***	***03***	***06***	***NT***	***06***	***03***	***NT***	***NT***	***NT***	***4***	***NT***	***NT***	***2***	***NT***
n= 10	***S***	***07***	***04***		***04***	***07***				***6***			***8***	
Proteus	***R***	***08***	***17***	***00***	***10***	***NT***	***NT***	***NT***	***NT***	***13***	***NT***	***NT***	***12***	***NT***
n= 17	***S***	***09***	***00***	***17***	***07***					***4***			***5***	

ANTIBIOGRAM

ISOLATED MICROORGANISMS	*RECOMMENDED CHOICE OF ANTIBIOTIC*
Staphylococcus species	Gentamicin 3 – 5 mg /kg bd Ceftazidine 0.5 – 2 g IM/IV
E.Coli	Ceftazidine 0.5-2g IM/IV Ceftriaxone 1g IV bd Amikacin 500mg/ kg bd Gentamicin 3 – 5 mg /kg bd
Proteus species	Gentamicin 3 – 5 mg /kg bd Ceftriaxone 1g IV bd Amikacin 500mg/ kg bd
Pseudomonas	Ceftazidine 0.5-2g IM/IV Gentamicin 3 – 5 mg /kg bd Amikacin 500mg/ kg bd Ciprofloxacin 250 mg bd
Streptococcus	Gentamicin 3 – 5 mg /kg bd Pencillin 0.5 – 5 mu IM/IV
Klebsiella	Ceftazidine 0.5-2g IM/IV Ciprofloxacin 250 mg bd Gentamicin 3 – 5 mg /kg bd Amikacin 500mg/ kg bd
Pneumococci	Ampicillin 0.5-2g IM/IV Tid Norfloxacin 400 mg bd
Gonococci	Ceftriaxone 1g IV bd Norfloxacin 400 mg bd

Categorization based drug therapy in SSI

SSI events are categorized into two groups based on intervention. One group is not having change in drug therapy and one group undergone the intervention based on resistance pattern. 162 patients did not have any change in therapy where as another 162 patients undergone the intervention based on their sensitivity pattern.

Table- 7: Based on intervention

GROUP	NO OF SSI EVENTS	PERCENTAGE
Group A (Intervention not done)	162	50
Group B (Intervention done)	162	50

Categorization based on curative time

A mean curative time as calculated for both the groups and the results are as follows: group A-8.72, Group B-3.88. A Mann–Whitney U test showed **curative time was significantly lower** in Group B (intervention) compared to Group A (no intervention), **U=372.5, p<0.001**. This suggests the intervention **significantly reduced** the time to recovery.

Table- 8: Based on mean curative time

GROUP	MEAN CURATIVE TIME (In days)
Group A (Intervention not done)	8.72
Group B (Intervention done)	3.88

8. LIMITATIONS

- The data collected is region-specific and may not fully represent bacterial resistance trends in other locations.
- The antibiogram was conducted using a selected panel of antibiotics.
- The study primarily focused on microbiological profiling rather than patient-specific factors such as genetic variations & immune status.

9. SUMMARY AND CONCLUSION

- Lack of uniform antibiotic policy and indiscriminate use of antibiotics may lead to emergence of resistant bacterial strains.
- The distribution of patients and SSIs across departments in this study reflects the varying risk profiles of different types of surgeries. General surgery and gynecology procedures contribute a significant number of SSIs, likely due to the invasive nature of many of the surgeries in these departments.
- Overall, wound classification remains a critical factor in understanding and preventing SSIs, with the need for tailored strategies to reduce infection risk in different categories.
- In this study, emergency surgeries were associated with a higher incidence of Surgical Site Infections (SSIs) compared to elective surgeries.
- The study results indicate a significant number of deep incisional SSIs, which is consistent with the literature indicating that this is the most common type of SSI, particularly for complex and invasive surgeries.
- The clinical manifestations observed in this study are integral to diagnosing and managing SSIs, with variations in severity depending on the type and depth of the infection. Understanding these manifestations allows clinicians to assess the severity of an infection and take appropriate measures to manage and prevent complications, ensuring better patient outcomes.
- This study has provided a comprehensive overview of the bacterial pathogens isolated from clinical samples, with Gram-positive bacteria (primarily Staphylococcus and Streptococcus) and Gram-negative bacteria (E. coli and Pseudomonas) being the most prevalent.
- The prevalence of MRSA (23.7%) and MSSA (76.3%) observed in this study aligns with global trends but underscores the ongoing challenge of managing antibiotic-resistant infections

in clinical settings. While MSSA remains the more prevalent strain, MRSA continues to pose significant treatment challenges due to its resistance to common antibiotics.

- These isolates showed high frequency of resistance to Ceftriaxone, Ampicillin, and Metronidazole. But in our study, Ceftriaxone, a third generation cephalosporins was commonly used before and after surgery to prevent SSIs which was found to be ineffective against most organisms.
- In this study, Gentamicin shows good sensitivity against most of the organisms. There should be an immediate response from the concerned authorities to check and also there is a need to emphasize the rational use of antimicrobials to minimize the misuse of available antimicrobials.
- In addition, regular antimicrobial susceptibility surveillance is essential for area-wise monitoring of the resistance patterns. Hence, it is imperative that all the health care professionals should take active role in infective control.
- Finally, there is need to develop an effective national and state level antibiotic policy and draft guidelines to preserve the effectiveness of antibiotics and for better patient management.

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11.RESEARCH PUBLICATIONS FROM THE STUDY

1. Bhargavi M, Sarathchandiran I, Kumar B. (2020). "A Review on Surgery and Antibiotic Susceptibility". International Journal of Research in Pharmaceutical Sciences, 2009-2015.
2. Bhargavi Manchikalapati, Karthikeyan R, Kumar B. (2024). "Microbiological Profile Assessment of the Bacterial Isolates from Surgical Site Infections". African Journal of Biological Sciences, 2505-2513.
3. Bhargavi M, Karthikeyan R, Kumar B. (2024). "Assessing Bacteriological Profiles and Targeting Resistant Bacterial Superbugs to Develop an Antibiogram Aiding in Antibiotic Selection". Cureus Journal of Medical Sciences, 1-12.

12.PAPER & POSTER PRESENTATIONS

Paper:

"Development of bacteriological profile and antibiogram targeting bacterial superbugs in surgery department" on 25th APTICON – 2022.

Poster:

"Bacteriological profile targeting bacterial superbugs of Surgical site infections and development of an antibiogram in surgery department" on 13th SPER – 2024.

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACEUTICAL SCIENCES

Published by JK Welfare & Pharmascope Foundation Journal Home Page: www.pharmascope.org/ijrps

A Review on Surgery and Antibiotic Susceptability

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Article History:

Received on: 20 Aug 2020
Revised on: 23 Sep 2020
Accepted on: 05 Oct 2020

Keywords:

Surgery,
Antibiotics,
SSI,
Antibacterial Resistance,
Culture Sensitivity,
Antibiogram

ABSTRACT

Surgery is a branch of medicine which employs operations as a part in the treatment of disease or injury. Surgical procedures have been utilized for thousands of years, yet they have always been difficult to some degree for various reasons. Surgical operations are generally classified into one of five categories: time, procedure, body part, invasiveness, and equipment used. Antibiotics are the most common drugs used before, during and after surgery to prevent infections. Antibiotic prophylaxis, thus, is a preventative strategy based on strong surgical techniques, strict asepsis in the operating room, and infection control in the hospital/primary care medical practise. Antibiotics are used to prevent infection in individual patients based on their risk of surgical infection, the severity of the SSI effects, the efficiency of prophylaxis, and the consequences. Antibiotic resistance is more common on the overuse and inappropriate use of antibiotics. Antibacterial resistance or drug resistance is when a bacteria does not respond to drugs which were meant to kill or weaken them. At present situation the resisitance is becoming major problem. It can be prevented by doing culture sensitivity test and by preparing antibiogram. An antibiogram is a tool that displays local microbiologic sensitivity information to help doctors make empiric judgments.

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ISSN: 0975-7538

DOI: https://doi.org/10.26452/ijrps.v10i4

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INTRODUCTION

The branch of medicine that includes operations in the treatment of disease or injury is known as surgery. It involves cutting, abrading, suturing and any alterations in the tissues and organs of the body. It has been routinely used for many years, but infection has always made it more difficult. Currently, surgery is an important element of the treatment of a variety of medical problems (Collinsdictionary.com, 2018; Walker and Whittlesea, 2012)

Surgery Types

Surgical operations are divided into five categories as below:

Based on Timing

3 types of surgery are done based upon timing which includes:

1. Elective: It is mainly carried on patient's request and mainly for non-life-threatening condition.

2. Emergency: It is carried out as soon as possible to save a person's life, limb, or functional capacity.

https://doi.org/10.33472/AFJBS.6.9.2024.2505-2513

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

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RESEARCH

MICROBIOLOGICAL PROFILE ASSESSMENT OF THE BACTERIAL ISOLATES FROM SURGICAL SITE INFECTIONS

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Volume 6, Issue 9, 2024

Received: 26 Apr 2024

Accepted: 07 May 2024

doi: 10.33472/AFJBS.6.9.2024.2505-2513

ABSTRACT

Monitoring of antibiotic resistance patterns continuously is required because of the evolution of new bacterial species and empirical antimicrobial therapy. A prospective study was conducted in a tertiary care teaching hospital with an inclusion of 688 patients. Among688patients314patients were found with Surgical Site Infections (SSIs) with an incidence of 45.6. SSIs were more common in females(51.6%) than males(48.4%), the infection rate was found to be higher in emergency procedures when compared to planned elective procedures ($P<0.05$, by using Chi-square test; OR=0.08). The surgical procedures of <45min has led to the development of more SSIs. Out of 314 SSIs, 328 organisms were isolated, of which Staphylococcus–97 was highest and majority of it were highly resistant to Ceftriaxone (84.5%) and highly sensitive to Gentamicin (92.8%). Streptococcus isolates were highly resistant to Ciprofloxacin (63.04%) and highly sensitive to Gentamicin (91.3%). Gentamicin showed good activity against most of the organisms, Ceftriaxone was commonly used before and after surgery but it was ineffective against most organisms. There is a need to emphasize the use of antimicrobials rationally to minimize the misuse of available antimicrobials. In addition to that there is an essentiality for regular antimicrobial susceptibility surveillance among area-wise monitoring of resistance patterns.

Keywords: Surgical site infection, Pathogens, Susceptibility, Gentamicin, Antimicrobial resistance.

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Assessing Bacteriological Profiles and Targeting Resistant Bacterial Superbugs to Develop an Antibiogram Aiding in Antibiotic Selection

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Review began 12/04/2024
Review ended 12/09/2024
Published 12/12/2024

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DOI: 10.7759/cureus.75574

Abstract

Introduction

The success of surgical procedures is becoming more threatened by the advent of multi-drug resistant (MDR) bacterial strains, sometimes known as superbugs. These resistant microorganisms frequently cause post-surgical infections, which raise morbidity, death, and medical expenses. With an emphasis on resistant strains, this seeks to create an antibiogram and a thorough microbiological profile of surgical infections in order to help choose the most effective antimicrobial therapy. The outcomes will lessen the effects of resistant microbial superbugs in surgical settings, optimize the use of antibiotics in turn, and improve infection control techniques.

Objectives

To identify and isolate the bacterial microbes that trigger post-surgical infections in patients. To determine the antibiotic resistance profiles of these bacterial isolates. To construct a local antibiogram for post-surgical infections, aiding in the appropriate selection of antibiotics.

Method

A prospective cross-sectional study was carried out in Government General Hospital, Nellore. Based on the sample size, 738 patients were taken. Patients were recruited based on eligibility criteria. A questionnaire was prepared, and details were collected. Gram-staining techniques were used to identify organisms. Biochemical tests were done to confirm the bacteria. Culture sensitivity tests were carried out by disk diffusion method to know the zone of inhibition. A structured antibiogram was developed.

Results

Of the 738 patients, 324 were found to have Surgical Site Infections (SSI). One-hundredand seventy two females were prone to SSI, which is a high number. Three-hudred and thirty eight organisms were identified among 324 SSI patients, mostly comprised of staphylococcus (28.6%) followed by *Escherichia coli* (*E.coli*) (21.3%). The gynecology department comprises more SSI followed by surgical (31.7%). Cephalosporins are commonly used antibiotics before and after surgery. It is found to be resistant to most organisms, whereas Gentamicin is found to be sensitive.

Discussion

It was evident that the more contaminated the wounds being operated on, the higher the SSI. Compared to scheduled elective surgeries, the infection rate for emergency procedures was nearly twice as high. There was no bacterial growth in 404 patients out of 738.

Conclusion

This study emphasizes the increasing difficulty in treating surgical infections caused by antibiotic-resistant organisms and the urgent need for accurate, data-driven methods of infection management. It is advised to employ an antibiogram to reduce the spread of resistant organisms because a significant percentage of samples are resistant to the most commonly used medications. National surveillance of microbes resistant to antibiotics must be established.

Categories: Obstetrics/Gynecology, General Surgery, Orthopedics
Keywords: antibiogram, anti-microbial resistance, e.coli, mdr bacteria infection, ssi, superbugs

Introduction

Surgical site infections (SSIs) represent one of the most common complications following surgery,

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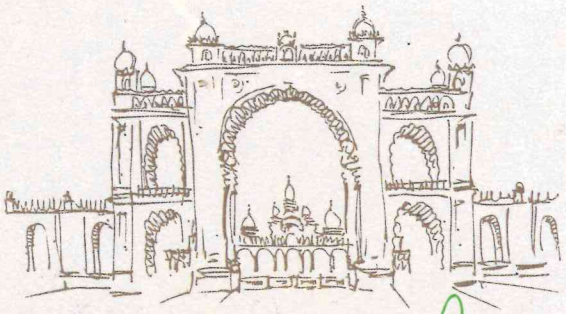

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BACTERIOLOGICAL PROFILE TARGETING BACTERIAL SUPERBUGS OF SURGICAL SITE INFECTIONS AND DEVELOPMENT OF AN ANTIBIOGRAM IN SURGERY DEPARTMENT

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